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ABSTRACT

This study investigated the relationships between 19 neurological abnormalities in school children and measures of school performance in reading, math, and nonacademic classroom behaviors. The sample of 45 children was given a standardized achievement test and the Draw-a-Person instrument to obtain academic variables. Nonacademic behaviors included quantified teacher ratings on a five-point scale of 12 variables including attention span, following directions, working hard for approval, emotional control, peer popularity, and friendliness. Results from the correlations identified the neurological "soft signs" most consistently related to academic/intellectual measures; these included combined hand, foot, and eye dominance, and tongue dysdiadochokinesia. Measures least related to academic performance involved both hand and feet tapping speed and bilateral hand tremor. Causal effect analysis of the findings suggest that "Neurological impairment" does not represent any sort of entity with specific educational relevance, and raises the possibility that further study of the relationship between neurologic variables and their relevance for educational planning may be a direction worthy of additional exploration. (Author/PC)

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CLASSROOM CORRELATES OF NEUROLOGICAL "SOFT SIGNS"

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The incidence of neurologic abnormalities in the public school population has been estimated as being somewhere between 5 and 20% (Cruickshank, 1967; Gruenberg, 1964; McCarthy, 1967), and among a population of learning disabled children as being as high as 30% (Thomas et. al., 1973). Although both the incidence and types of various "neurological soft signs" have been fairly well investigated and described (Gubbey et. al., 1965; Lukas et. al., 1965; Paine, 1962), their relationship to specific academic and classroom behavioral variables has not been reported. This study investigated the relationships between 19 neurological "soft signs" and measures of school performance in reading and arithmetic skills, as well as a number of nonacademic classroom behaviors.

METHOD

Subjects. A sample of 45 children, mean age 9 years, composed of approximately equal numbers of boys and girls with I.Q. in the 90's, was randomly selected from regular primary grade classes, on the basis of teachers' willingness to participate in the study.

Measures. Nineteen neurological measurements were chosen from diagnostic procedures commonly used in the evaluation of "soft

signs" in children (eg. Thomas et. al., 1973).

In the determination of which specific measures and procedures to include, the choice was determined by the recommendations of a child neurologist experienced in dealing with learning disorders. Neurological variables included quantified measures of bilateral hand and foot tapping rates; hand tremor; right-left orientation; mirror movements; finger tip symbol recognition; a measure of dysdiadochokinesis; and extent of the development of a strong lateral preference, measured independently for hand, foot, and eye dominance.

Academic variables included performance on a standardized reading achievement test (Wide Range Achievement Test) and ranking in arithmetic skills, with an estimate of nonverbal intellectual ability measured by the Draw-a-Person Test. Nonacademic classroom behaviors included quantified teacher ratings on a five point scale of 12 variables including attention span, following directions, working hard for approval, emotional control, peer popularity, and friendliness.

The 12 behavior rating items had been pretested with the classroom teachers, and test-retest reliability over a three week period was found to be $> .90$ ($p < .0001$).

Analysis. Data were correlated using the BMD-03D program, with a total of 19 neurological variables correlated with 3 intellective/academic measures and 12 behavioral measures, or 275 coefficients. Significance values for the coefficients were calculated for one-tailed tests.

Procedure. Children were ranked on academic and behavioral variables, tested with the achievement test, and then individually examined on neurological measures and the Draw-a-Person Test within a one week period. Data from all measures were then analyzed, with any coefficient greater than .243 considered significant (with N 46, r .243 = p.05).

RESULTS

From the total of 275 correlations, 114 coefficients reached statistical significance. The neurological "soft signs" which were most consistently related to academic/intellective measures included combined hand, foot, and eye dominance, and tongue dysdiadochokinesia, while those least related to these measures involved both hand and feet tapping speed and bilateral hand tremor. Soft signs most consistently related to behavioral measures included both unilateral and bilateral hand tremors, hand dominance, mirror movements, right-left orientation, and dysdiadochokinesia, while those least related to behavioral variables included eye dominance, and more complex measures of right-left orientation. (Table 1).

Some neurological measures such as hand dominance, tongue dysdiadochokinesia, and number of seconds standing on one foot, for example, correlated at significant levels (all $p < .005$) with all cognitive variables, and with 4-5 behavioral variables, while other neurological measures such as hand and foot tapping

speed were not correlated at significant levels with any academic variables, but were each correlated with 3-4 behavioral variables.

Magnitude of the correlations ranged from almost zero (eg. correlations between mirror movements and behavioral ratings of "easy to control" and "friendly" were .001 and .002, respectively) to .841 (between measures of foot dominance and WRAT reading standard scores).

DISCUSSION

Although it is possible that approximately 13 of the 275 coefficients might reach statistical significance at the .05 level by chance, the fact that 114 coefficients reached significance at or beyond this level indicates that there may be substantial relationships between discrete neurological measures and given variables related to children's school performance and behavior. It was of interest to note that some neurological measures (eg. eye dominance) were significantly related to cognitive but not behavioral variables, while other neurological measures (eg. bilateral hand tremor) were related to behavioral more than cognitive variables, suggesting that neurological integrity (or its absence) does not necessarily relate to some condition with given common educational implications. Specifically, this raises the distinct possibility that assignment of children to specific class placement, or

prescribing generic educational approaches to children classified as "neurologically handicapped", may represent a gross oversimplification.

In effect, findings from this study suggest that "neurological impairment" does not represent any sort of entity with specific educational relevance, and raise the possibility that further study of the relationship between neurologic variables and their relevance for educational planning may be a direction worthy of further exploration.

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Table 1

Correlations between Neurological Measures and Various Cognitive and Behavioral Variables

Neurological Measure	Arithmetic Rank	WRAT Reading	D-A-P S.S.	"Attention"	"Sits Still"	"Attention Span"	"Follows Directions"
Finger Tip Symbol Writing(Rt. Hand)	*** .559	*** .621	-.121	*** .720	.205	*** .742	*** .739
Finger Tip Symbol Writing(L. Hand)	*** .522	*** .588	-.183	*** .780	** .293	*** .826	*** .820
Seconds Balancing on one foot	*** .357	*** .393	*** .497	*** .535	** .304	*** .617	*** .580
Tapping Speed/10 seconds (Rt. Hand)	.231	.242	*** .440	*** .446	.174	*** .462	*** .449
Tapping Speed/10 seconds (L. Hand)	.085	.097	*** .347	** .297	.164	*** .370	** .308
Tapping Speed/10 seconds (Rt. Foot)	.181	.126	*** .415	*** .404	.142	*** .393	*** .342
Tapping Speed/10 seconds (L. Foot)	.121	.154	*** .339	*** .548	.185	*** .492	*** .463
Hand tremor, eyes closed (Rt. Hand)	*** .377	*** .464	-.221	*** .695	* .245	*** .666	*** .732
Hand tremor, eyes closed (L. Hand)	* .264	.205	-.198	*** .457	.222	*** .503	*** .569
Hand tremor, eyes closed (Both Hands)	.225	*** .442	-.100	*** .422	* .272	*** .338	*** .384
Hand dominance	*** .662	*** .717	*** .358	*** .679	** .296	*** .695	*** .719
Foot dominance	*** .773	*** .841	** .291	*** .670	.231	*** .644	*** .704
Eye dominance	*** .468	*** .368	* .278	-.006	.063	-.002	.042
Right-Left Orientation (Single)	*** .424	*** .429	.113	* .279	.018	** .302	* .282
Right-Left Orientation (Complex)	*** .394	*** .430	.192	.219	.197	.196	** .297
Right-Left Orientation (Very Complex)	*** .511	*** .526	.035	.184	.203	.185	* .243
Mirror Movements (Rt. Hand)	*** .453	*** .585	.089	*** .586	* .276	*** .601	*** .587
Mirror Movements (L. Hand)	*** .501	*** .647	-.037	*** .593	** .307	*** .617	*** .636
Tongue dysdiadochokinesis	*** .618	*** .598	*** -.368	*** .341	.100	*** .391	*** .447

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Table 1 (cont.)

Neurological Measure	Easy to Control	Even Tempered	Neat Written Work	Works Hard For Approval	Frequently Volunteers	Cooperative	Well liked	Friendly
Finger Tip Symbol Writing (Rt.Hand)	.045	.004	.167	.056	-.177	.128	-.020	-.093
Finger Tip Symbol Writing (L. Hand)	.149	.065	.089	.034	-.221	.120	.001	-.025
Seconds Balancing on one foot	-.189	-.076	.065	-.129	.103	-.209	-.064	-.192
Tapping Speed/10 seconds (Rt.Hand)	.110	.119	-.067	-.214	-.205	-.189	-.189	.111
Tapping Speed/10 seconds (L. Hand)	.035	.074	.073	-.204	-.231	-.108	-.218	.161
Tapping Speed/10 seconds (Rt.Foot)	-.014	.076	.106	-.321**	-.028	-.225	-.084	.072
Tapping Speed/10 seconds (L. Foot)	.024	.026	-.053	-.138	-.024	-.075	-.114	.212
Hand tremor, eyes closed (Rt. Hand)	.145	.038	-.011	.182	-.126	.251*	-.100	-.191
Hand tremor, eyes closed (L. Hand)	.268*	.096	.041	.257*	-.107	.324**	.055	-.108
Hand tremor, eyes closed (Both Hands)	.431***	.349***	.080	.239	.005	.262*	.070	.141
Hand dominance	-.186	-.230	.136	-.083	.129	-.273*	.093	-.123
Foot dominance	-.194	-.342***	.158	.114	.242	.005	.004	-.018
Eye dominance	-.166	-.232	.134	-.106	-.189	-.350***	-.213	-.131
Right-Left Orientation (Single)	-.018	-.039	-.030	-.260*	-.119	-.108	-.120	.294**
Right-Left Orientation (Complex)	-.139	-.184	-.145	-.246*	-.042	-.115	-.153	.076
Right-Left Orientation (Very Complex)	.320**	.233	-.093	-.203	-.154	.015	-.266*	.249
Mirror Movements (Rt. Hand)	-.178	-.115	-.048	-.004	.065	-.052	-.201	-.278
Mirror Movements (L. Hand)	.001	.024	.096	.097	.215	.166	-.122	-.002
Tongue dysdiadochokinesis	-.060	-.139	-.286*	-.162	-.157	-.066	-.308**	-.205